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ABSTRACT

The American Chemical Society (ACS) sponsored a conference for educators and chemists to design strategies for implementing the recommendations made in the 1984 ACS publication, Priorities, Partnerships, and Plans: Chemistry Education in the Schools. Participants submitted proposals for mini-grant funding to the ACS Prehigh School Science Program of which ten were awarded. This report presents highlights of the final reports of each funded project. The strategy, findings, and impact are outlined for each state model. State models and projects include: (1) Oregon (curriculum guide for classroom demonstrations); (2) Alabama (inexpensive science activities); (3) Indiana (hands-on teacher workshop); (4) Minnesota (state conference for elementary teachers); (5) Connecticut (workshop on science demonstrations); (6) Colorado (workshop for middle school physical science teachers); (7) Ohio I (videotape of a physical science classroom lesson); (8) Ohio II (two-day workshop for elementary teachers); (9) Washington, D.C. (demonstration of a kitchen chemistry kit); and (10) Pennsylvania (hands-on workshops for fifth and sixth grade teachers). Also included is a statement of how the projects addressed the needs of elementary science. (ML)

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History of the Project

The American Chemical Society (ACS) invited 25 educators and chemists to meet at the Lawrence Hall of Science in Berkeley, California, on April 12–14, 1985. Conference participants were selected for their expertise and interest in the area of prehigh school science education and for their geographic networking potential. The National Science Foundation funded this conference so that participants could design strategies for implementing the recommendations made in the 1984 ACS publication "Priorities, Partnerships, and Plans: Chemistry Education in the Schools."

Participants were asked to design plans suitable for implementation in their local communities. These plans were to specifically address the following needs of elementary and middle school teachers and students:

- Prehigh school teachers need regional in-service workshops to help them feel more comfortable with the use of hands-on science activities in the classroom and to become more knowledgeable of physical science content. Local secondary science teachers and college and university faculty need to be encouraged to conduct physical science workshops for prehigh school teachers in their local communities.
- While good physical science curriculum materials already exist, these materials need to be repackaged and updated in order to make them more useful to prehigh school classroom teachers.
- There are enormous time demands placed on elementary school teachers. If hands-on science instruction is to occupy any significant part of the school day, deliberate attempts must be made to relieve teachers of some of their more time-consuming duties.
- Elementary teachers need greater awareness of the support systems that exist outside of their school districts. They should be encouraged to make use of college and university faculty, industry, museums of science and technology, and local professional organizations to support their efforts to improve prehigh school science instruction.

Many implementation strategies were developed and discussed by the conference participants. At the close of the conference, participants were asked to refine their plans in cooperation with the local school system and other support groups available in their communities. Participants submitted proposals for mini-grant funding to the ACS Prehigh School Science program, enabling ACS to help them implement their refined plans.

Ten proposals were awarded mini-grants of $1000 or less based upon each plan's feasibility and its potential for addressing the stated needs. A full report on each completed project was submitted to the ACS Prehigh School Science staff associate in May 1986 for compilation and publication.

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Summary of Implementation Proposals

Funded by Prehigh School Science Mini-Grants in 1985

Oregon Ms. Christie Borgford, Oregon Episcopal School (Portland), was awarded $500 to produce a curriculum guide and present workshops to help pre-high school teachers develop classroom demonstrations and activities.

Alabama Dr. Joe Burns, University of Alabama—Birmingham, was awarded $1000 to develop a series of inexpensive science activities for elementary students and to demonstrate their use to elementary teachers.

Indiana Dr. Dorothy Gabel, Indiana University—Bloomington, was awarded $500 to conduct a hands-on science workshop for elementary teachers who were willing to share the information and activities with other teachers in their schools.

Minnesota Mr. Kenneth Jeddeloh, treasurer, Minnesota Science Teachers Association, was awarded $1000 to hold a state conference on hands-on science for elementary teachers.

Connecticut Mr. Ron Perkins, Greenwich High School, was awarded $500 to conduct a workshop on science demonstrations for elementary teachers. The workshop would feature Dr. Lee Summerlin, University of Alabama—Birmingham, as presenter.

Colorado Dr. Harold Pratt, science coordinator, Jefferson County Public Schools, and Mrs. Gail Foster, Biological Sciences Curriculum Study, Colorado Springs, were awarded $1000 to conduct a two-day workshop for middle school physical science teachers based on the Chemical Education for Public Understanding Project (CEPUP) from the Lawrence Hall of Science in Berkeley, California.

Ohio I Mrs. A. M. "Mickey" Sarquis, Miami University—Middletown, was awarded $500 to produce a videotape of a physical science classroom lesson for use during teacher in-service sessions.

Ohio II Dr. Cliff Schrader, Dover High School, and Mrs. Gail Foster were awarded $1000 to conduct a two-day workshop for elementary teachers in the Dover Public School District during teacher in-service days.

Washington, D.C. Ms. Gloria Tucker, NSTA/Beers Model Elementary Science Program, was awarded $1000 to demonstrate to fourth-grade teachers the use of a "Kitchen Chemistry" kit developed by the NSTA/Beers Model Elementary Science Program.

Pennsylvania Dr. Karen Doyle Walton, Allentown College of St. Francis de Sales, was awarded $1000 to conduct a series of hands-on workshops for fifth- and sixth-grade teachers using Robert C. Mebane's and Thomas R. Rybolt's book, *Adventures with Atoms and Molecules: Chemistry Experiments for Young People* (Enslow Publishers, Inc.).

Results of Implementation Projects

Final reports received from the 10 project facilitators indicate that these small grants had a far-reaching effect in their local communities. The 10 mini-grants generated 31 hands-on science workshops for prehigh school teachers; provided classroom science equipment to four school districts; allowed nine school districts to field test the CEPUP chemistry program from the Lawrence Hall of Science; and spurred the creation of 10 new student activities, two new curriculum guides, and one videotape.

Highlights of Final Reports

Oregon Model

Strategy

The project facilitator compiled a curriculum guide entitled "Oregon Matters." This guide contains directions for 55 elementary chemistry activities and demonstrations, and 18 pages of chemistry background for teachers. The guide was distributed to teachers during two sessions at the Oregon Science Teachers Association fall conference and during a 10-hour continuing education course at Portland State University. Session participants were given plastic bins numbered to coincide with the activities in the guide. The bins contained all the equipment necessary to practice each activity. Open sharing of ideas and successes was encouraged in the sessions. In this way, teachers learned both from their peers and from professionals more familiar with the activities and the science content.

Funding

In addition to the ACS mini-grant, participants were charged a $15 registration fee. The University's chemistry lab was used, and the ACS local section cosponsored the project so that participants were able to receive one graduate hour of continuing-education credit.

Impact

The communications network this project brought about was an extremely positive outcome. Participants expressed a desire to continue sharing ideas, activities, materials, and assistance with the university faculty, ACS local section members, and other teachers.

Alabama Model

Strategy

Ten hands-on science activities that promote divergent thinking were developed and tested by Dr. Joe Burns. Each activity uses inexpensive materials and gives students practice with science process skills. The activities include extensions that permit students to use creative and higher-level thinking strategies. Activity extensions make use of futuristic speculations, exploration of personal feelings, synthesis of seemingly unrelated phenomena, open-ended investigations, and brainstorming techniques.

Activities have titles such as "Glue Factory," "Be-Leave It or Not," "Sudden Impact," "The ABC's: Acids, Bases, Colors," "Sweet Sleuth," "March of the Ants," and "The Nose Knows." The activities were distributed during workshop presentations and summer in-service sessions for teachers in three Alabama school districts and one elementary school in Pennsylvania. They were also used in courses taught by education professors at the University of Alabama, University of South Carolina, and Southeastern Louisiana University.

Funding

The ACS mini-grant funds were combined with support from the universities and school districts involved.

Impact

Research documents that prehigh school students are turned off very early to the physical sciences. This problem may be exacerbated by the way in which science is traditionally taught to younger students. Students are given a distorted view of the nature of science when they are presented only with facts, definitions, numbers, and the logical processes of the scientific method. Students seldom see that science is also a creative endeavor. The activities designed in this project encourage the creative idea-generating skills that scientists must use. The activities do not have a single correct answer. Instead, students learn to ask "what if" questions and to explore new ideas. This approach may serve to promote greater scientific curiosity in younger students.

Indiana Model

Strategy

Dr. Dorothy Gabel held a two-hour, after-school workshop for 21 teachers of grades four through six from the Archdiocesan Schools in Indianapolis. Teachers volunteered their time. In exchange, they were provided with enough supplies and chemicals to repeat each of the experiments in their own classrooms as well as in the classroom of a colleague. Three activities dealing with chemical reactions and changes of state were practiced in the workshop. These activities were melting salt and baking soda in a phenol red system to determine cause and effect relationships, boiling Freon 11 at room temperature and testing for the presence of water using cobalt chloride, and using a butyl stearate system to show changes of state from solid to liquid at room temperature. All activities used zip-lock sandwich bags as reaction vessels.

Funding

Enough supplies were furnished for teachers to repeat the experiments with 60 students (two classes) working in pairs. These supplies cost $20 per teacher.

Impact

A survey to evaluate the workshop's effectiveness was sent to all the teacher participants two weeks after they completed the workshop. Responses were positive. Giving the teachers a box full of supplies and equipment guaranteed that the children did each of the chemistry experiments instead of only seeing demonstrations. Teachers said they were surprised at the small amount of equipment necessary to produce many insights into chemical changes. Some teachers incorporated the activities into their regular units on heat and temperature. Several teachers had already convinced colleagues to try the

experiments with their classes as well. Parents commented on how much their children enjoyed the hands-on science activities.

Minnesota Model

Strategy

Mr. Kenneth Jeddeloh applied the mini-grant toward the Minnesota Science Teachers Association (MSTA) hands-on science conference for elementary teachers in the Minneapolis–St. Paul area. The conference took place on a Saturday and consisted of a keynote address and 14 workshop sessions. More than 100 elementary teachers voluntarily attended this conference. Three of the sessions dealt directly with chemistry activities appropriate for the elementary classroom. Other sessions either demonstrated strategies to be used with hands-on elementary science or hands-on science units for other disciplines. Packets of hands-on science curriculum materials were given free to participants.

Funding

The ACS mini-grant was used in combination with funding from the Northern States Power Company and the MSTA. Each presenter and the keynote speaker received a modest honorarium. Participants were served coffee, treats, and lunch.

Impact

Although a snowstorm on the day of the conference prevented many elementary teachers from attending, those who did participate were very positive. This was the first elementary science conference held in Minnesota. The MSTA is now looking forward to sponsoring an annual elementary science conference.

Connecticut Model

Strategy

Mr. Ron Perkins and Dr. Babu George of Sacred Heart University (Bridgeport), cohosted a full-day workshop entitled "Science Demonstrations and Experiments for the Elementary School." The workshop was held in the chemistry department of Sacred Heart University for 40 participants from 35 elementary schools. Dr. Lee Summerlin and Ms. Christie Borgford presented the workshop. Each participant practiced several hands-on science activities and received a copy of the book *Adventures with Atoms and Molecules*.

Funding

The ACS mini-grant was combined with funding from the Fairfield–Westchester Science Education Center and support from Sacred Heart University. Refreshments and a reception were provided along with the chemistry activity book.

Impact

This project demonstrates the successful interaction that can take place between university, secondary, and elementary science educators for the improvement of prehigh school science education.

Colorado Model

Strategy

This grant provided an opportunity for nine Colorado school districts to field test curriculum materials that introduce personal and societal issues into the middle school physical sciences. The project brought Dr. Herb Thier, director of the Chemical Education for Public Understanding Project (CEPUP) at Lawrence Hall of Science, to conduct a workshop for 22 Colorado teachers and science coordinators. The workshop was hosted by Jefferson County Public Schools. The workshop content included three CEPUP modules: "Chemical Survey," "Solution and Pollution," and "Determining Threshold Limits." Trial teaching of at least two CEPUP units was an expectation and condition for attending the workshop. Each unit contains from five to eight hands-on activities and requires an equal number of classroom periods. Teachers provided direct feedback about the success of the units to the

CEPUP project headquarters in Berkeley, California.

Funding

The ACS mini-grant provided a financial incentive for the local school districts to improve their physical science curricula. The participating school districts supported the project by contributing nearly $4000 worth of immediate expenditures in the form of release time, travel for the participants, and purchase of the CEPUP kits.

Impact

At the expense of CEPUP, Dr. Herb Thier will provide follow-up support to the field trial teachers during the next two years. Participating teachers will be asked to conduct workshops for other teachers when the CEPUP materials are adopted by the participating school districts.

Ohio Model I

Strategy

Mrs. A. M. "Mickey" Sarquis produced a videotape of a chemistry activity she developed about the polymer popularly known as Slime. The videotape portrays this activity being taught in an elementary classroom. Students produce Slime in a paper cup by mixing polyvinyl alcohol and sodium borate. They visualize the production and cross-linking of polymer units by forming human chains in a kinesthetic game. Students then investigate the properties of Slime and compare this polymer to other polymers with which they may be familiar. The videotape and accompanying written documentation were presented to teachers during 12 teacher workshops. The teachers view the videotape, discuss the activity, and then practice the preparation and dramatization of the polymer production.

Funding

The ACS mini-grant was combined with the resources of Miami University—Middletown and two community support groups: the Community Approach to Science in the Elementary Schools project (CASES), and the Simple Hands-on Activities Reinforce Education project (SHARE).

Impact

The activity was well received by the elementary teachers during the 12 in-service sessions. Based on teacher input from these sessions, the videotape is being revised to include information on the science and pedagogy involved in the activity.

Ohio Model II

Strategy

Dr. Cliff Schrader teamed with Mrs. Gail Foster to conduct two days of chemistry instruction for 50 elementary teachers in the Dover Public School District. The team developed hands-on activities that were interesting and fun, but also nonthreatening to the elementary teachers who had limited chemistry backgrounds. One of the new activities deals with dissolving and solutions.

Funding

Mini-grant funds were supplemented by school district funds so these workshops could be offered during district teacher in-service days.

Impact

The elementary coordinator for Dover schools reports she has observed many teachers implementing the hands-on science activities presented in this workshop. The project facilitators note another positive outcome was the powerful synergy that resulted from combining the talents and energies of educators with different areas of expertise. The secondary teacher felt he learned more about child development and different learning styles, while the elementary teacher felt she gained technical information and a deeper understanding of the nature of science. This team approach to the chemistry workshop ensured that both content and pedagogy were provided to the participating teachers.

Washington, D.C., Model

Strategy

The NSTA/Beers Model Elementary Science Program identified chemistry activities that met the objectives of the Washington, D.C., Public Schools' Competency-Based Curriculum at the intermediate grade levels. A hands-on science unit entitled "Kitchen Chemistry" was developed to help fourth-grade teachers meet the required chemistry objectives at that grade level. Equipment kits were assembled so that classroom teachers would have ready access to all the materials required to implement the "Kitchen Chemistry" unit with their students. Fourth-grade teachers in 12 Washington elementary schools attended a full-day workshop on how to use the materials and present the activities included in the kit. Kits were field tested in the 12 elementary schools, and an evaluation of the project was conducted by the school system's psychometrists.

Funding

The ACS mini-grant was combined with funding from the National Science Teachers Association (NSTA) and the Washington, D.C., Public School System.

Impact

By providing complete kits and in-service training to the teacher-users, this project ensured that elementary teachers would engage in a hands-on, process approach to teaching the required chemistry curriculum objectives. In addition, each participating school's principal agreed to allow the fourth-grade teachers to meet during teacher planning days to share strategies they found effective as they implemented the "Kitchen Chemistry" kit. The test data collected from the Competency-Based Assessment instrument used in the schools are presently being analyzed by the school system to determine whether fourth-grade students involved in the project performed better on chemistry-related concepts than did a matched group of fourth-graders who did not participate.

Pennsylvania Model

Strategy

The Allentown College of St. Francis de Sales conducted a chemistry workshop for 23 fifth- and sixth-grade teachers during December, January, and February of 1985–86. Teacher participants represented public and private schools in the greater Lehigh Valley and Philadelphia areas. They attended three half-day Saturday workshops where they were guided through the experiments and information presented in the book *Adventures with Atoms and Molecules*. Each teacher was given a large laundry basket containing all the equipment and materials necessary to conduct each experiment with small groups of students in his or her classroom. The experiments were safe and used materials commonly available in grocery stores. After trying the experiments with students, the teachers returned to the workshop to ask staff members any questions that arose and to share with their peers the methods they used to present the lessons and organize the classroom activities.

Funding

In addition to the $1000 ACS mini-grant, this project was funded by a $2500 grant from the Woodrow Wilson Foundation and a $1500 in-kind contribution from Allentown College. These funds provided each teacher with more than $50 in classroom lab supplies, a copy of the chemistry activity book, and a $40 stipend.

Impact

The 23 teacher participants tried all the activities with the 1116 students in their classrooms. At the end of the final workshop, all participants completed an evaluation form. The results indicate that the teachers found this project applicable to their teaching needs, and so interesting that they wanted to participate in more workshops of this nature. Teachers reported that the majority of the concepts introduced during the workshops were entirely new to them.

How Projects Addressed the Needs of Elementary Science

Each implementation project provided an opportunity to practice the use of hands-on science activities appropriate for elementary students and the chance to learn more science from local science educators. Sharing ideas and methods between college, precollege, and prehigh school faculty proved to be an effective and positive way to develop communication networks for elementary science education at the local and regional level.

The implementation projects used curriculum materials that already existed but with which many of the prehigh school teachers were unfamiliar or did not have the training to use effectively in their classrooms. The teachers found it extremely valuable to share with their peers a variety of strategies and management techniques for implementing the activities.

One of the barriers to hands-on science programs in elementary classrooms is the time required to obtain, organize, and manage the myriad of materials needed to conduct the activities. Several of the model implementation projects overcame this barrier by providing teachers with supplies or kits stocked with all the necessary materials. This saved time for the teachers and virtually guaranteed that the teachers conducted the activities in their classrooms after they were introduced to them in the workshop settings.

Teachers in these model implementation projects showed a greater awareness of local support systems after their participation. Some participants have since shared their experiences at science teaching conventions, subscribed to newsletters and journals concerned with elementary science education, and enrolled in courses to help them continue to improve their knowledge of elementary science.

The 1985–86 ACS Prenigh School Science Mini-Grant Project appears to have built many bridges—bridges that link the ACS, ACS local sections, colleges, universities, science and technology museums, and secondary science teachers to elementary teachers in public and private schools across the nation. The mini-grant project demonstrated how a small financial boost can initiate an extensive program of improvements in prehigh school science education.

The 1986–87 ACS Prehigh School Science Mini-Grant Project will build another bridge to link parents to this prehigh school science education network. A planning conference to design strategies for promoting parental involvement in science education was held October 10–12, 1986, at ACS headquarters. Mini-grants will be awarded in 1987 to groups who wish to implement the strategies.

AMERICAN CHEMICAL SOCIETY
Education Division
Prehigh School Science Program
1155 Sixteenth St., N.W.
Washington, D.C. 20036
(202) 452-2113